

United States General Accounting Office

GAO

Report to Congressional Requesters

AD-A281 315



March 1990

NUCLEAR WASTE

Quarterly Report as of
September 30, 1989



94-20779



158

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-202377

March 2, 1990

The Honorable J. Bennett Johnston
Chairman, Committee on Energy
and Natural Resources
United States Senate

The Honorable James A. McClure
Ranking Minority Member
Committee on Energy and Natural Resources
United States Senate

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On March 26, 1984, you requested that we provide quarterly status reports on the Department of Energy's (DOE) implementation of the Nuclear Waste Policy Act of 1982 (NWPA). The act established a national program and policy for safely storing, transporting, and disposing of civilian nuclear waste in an underground repository. December 1987 amendments to the act directed, among other things, DOE to characterize (investigate) a site at Yucca Mountain, Nevada, to determine if it is suitable for a repository.¹

During the July-September 1989 quarter, DOE was preparing to begin in November 1989 the construction of an exploratory shaft facility at the site for underground characterization tests and experiments. However, in November, DOE decided to delay the facility's construction until 1992. This quarterly report discusses (1) DOE's readiness to begin construction of the facility and (2) the impact of recent changes in DOE's schedule and approach for developing a repository.

Results in Brief

At the quarter's end, DOE was not ready to begin site characterization, including construction of the exploratory shaft facility, because of (1) continuing delays in developing quality assurance programs, (2) unresolved criticisms of the design of the exploratory shaft facility and DOE's proposed method for constructing it, and (3) a decision by the state of Nevada not to issue necessary environmental permits. In addition, the Nuclear Regulatory Commission (NRC), Nevada, and a group representing utilities had raised many significant concerns about DOE's approach to characterizing the site. For example, Nevada had urged DOE to conduct tests at or near the surface of the site (surface-based testing) to

¹The Nuclear Waste Policy Amendments Act of 1987, contained in the Budget Reconciliation Act for Fiscal Year 1988 (P.L. 100-203).

investigate potentially disqualifying site conditions before conducting underground investigations in the exploratory shaft facility.

In November 1989, DOE extended the repository's projected operating date by 7 years, from 2003 to 2010. In doing so, it delayed by 3 years beginning construction of and testing in the exploratory shaft facility until November 1992 and September 1995, respectively. DOE said the delay in these activities will allow it to overcome current program obstacles. In addition, DOE intends to evaluate early the suitability of the site by conducting tests from the site's surface beginning in January 1991. DOE's new site characterization schedule and approach are intended to result in a technically sound and cost-effective program. An early indication of its success will be DOE's effectiveness in resolving outstanding concerns about its plan for site characterization.

Background

NWPA, as amended, requires DOE to issue a site characterization plan, obtain comments on the plan from NRC and the state of Nevada, and hold public hearings on the plan before constructing an exploratory shaft facility at Yucca Mountain. Issued in December 1988, DOE's plan described the agency's approach to data collection and the preliminary design of the repository. Construction of and testing in the exploratory shaft facility were to have been early steps in site characterization. The facility would have consisted of surface facilities, two shafts, and underground test areas in tunnels and rooms.

NRC, Nevada, and a utility group commented on the plan after its issuance. NRC and the utility group concluded that the plan provided a useful basis for proceeding with site characterization. Nevada, however, concluded that the plan did not comply with NWPA because it did not set forth a rigorous program of scientific investigation to establish the site's suitability. Each of the parties also expressed specific concerns that they said required DOE's timely attention.

Three Obstacles Prevented DOE From Beginning Site Characterization

DOE had planned to start site characterization activities in November 1989 by beginning construction of an exploratory shaft facility for underground tests and experiments. However, DOE was not ready to do so because it had not

- demonstrated that its quality assurance programs for site characterization meet NRC's requirements,

- resolved concerns about the design of the exploratory shaft facility and the proposed method for constructing it, and
- obtained environmental permits from the state of Nevada that are necessary for facility construction and other site characterization activities.

(App. I discusses these issues in detail.)

DOE Had Not Demonstrated the Adequacy of Its Quality Assurance Programs

NRC's repository licensing regulations require DOE to develop and implement quality assurance programs. The programs govern the conduct of work related to developing a repository and help ensure that work to be used in a future licensing proceeding will be of sufficient quality. In 1985 DOE agreed that it would not begin site characterization until it has demonstrated, to NRC's satisfaction, that the necessary programs are in place. For its part, NRC has agreed to "accept," or approve, the programs as adequate for beginning site characterization when DOE demonstrates each program's adequacy.

DOE's schedule for obtaining NRC's approval has slipped continually. In July 1988, for example, DOE anticipated that it would be ready by May 1989 to demonstrate to NRC that its programs are adequate for beginning site characterization. By the July-September 1989 quarter, however, DOE's planned date for obtaining NRC's approval had slipped to January 1, 1990.

In commenting on DOE's site characterization plan, NRC said that none of DOE's quality assurance programs met NRC's requirements, and it questioned whether DOE would meet its January 1990 goal. Consequently, NRC restated its earlier position that DOE should not start site characterization until satisfactory quality assurance programs are in place. The utility group also criticized DOE's efforts to develop such programs as "slow and unsteady."

In November 1989 DOE once again delayed its scheduled date for demonstrating the readiness of its quality assurance programs. DOE now expects to have the necessary programs in place and approved by NRC by August 1990.

DOE Had Not Resolved Concerns About the Design and Construction of the Exploratory Shaft Facility

Because the exploratory shaft facility will become part of a repository, the facility must be designed and constructed so as not to jeopardize the repository's capability to isolate waste. In July 1988, however, NRC found that DOE had not applied sufficient quality assurance measures in designing the facility. For example, although NRC requires that site characterization work be conducted in a manner limiting, to the extent practical, adverse effects on long-term repository performance, NRC found that DOE had not considered adequately the potential adverse effects of locating the two exploratory shafts in areas possibly subject to flooding and erosion. This problem and others led NRC to conclude that DOE's preliminary design for the exploratory shaft facility did not comply with NRC's regulations for licensing repositories.

In October 1988 DOE agreed to comply with NRC's quality assurance standards in future design activities and to assess whether earlier design work met the standards. According to NRC, however, DOE's site characterization plan and design assessment report did not consider 11 applicable regulatory requirements. In addition, NRC said DOE had not considered adequately at least 30 of 52 other requirements and may have overlooked key information such as the possibility of a fault near the proposed shaft locations. Therefore, NRC objected to facility construction until DOE demonstrates that both the design and the process used to develop the design are adequate.

In its comments on DOE's site characterization plan, the state of Nevada also expressed concerns about DOE's design for the exploratory shaft facility. For example, the state said DOE intended to design the facility to withstand an earthquake that is less severe than the plan implied could occur near the site. Given that the facility would be integrated into a future repository, the state said a more conservative design would be more scientifically acceptable. Nevada recommended that DOE not proceed with the facility's construction until design issues are resolved and until sufficient information is available to provide reasonable assurance that the integrity of the repository will not be compromised by an inadequate seismic design.

In addition, the Nuclear Waste Technical Review Board² questioned DOE's planned use of conventional excavation techniques. Such techniques, the Board said, would disturb shaft and tunnel walls, introduce water into rock fractures, and complicate interpretations of test results.

²The Nuclear Waste Technical Review Board was created by the 1987 amendments to NWPA to evaluate independently the technical and scientific validity of DOE's site characterization activities.

The Board believes that many of its concerns can be reduced or eliminated if DOE uses what the Board called "state-of-the-art" excavation techniques. In the Board's view, these techniques would be quicker and less costly, and would facilitate investigations of potential faulting.

DOE Had Not Obtained Permits Needed for Site Characterization

DOE must obtain environmental permits from the state of Nevada before it can begin construction of the exploratory shaft facility or other site characterization activities. Nevada has not issued these permits, and it currently has no plans to do so. On November 1, 1989, Nevada's attorney general issued an opinion saying the state has successfully "disapproved" Yucca Mountain as a repository site because the Congress did not respond to two joint resolutions of the Nevada legislature. The resolutions, the attorney general asserted, constituted the state's formal "notice of disapproval" under NWPA, as amended. Consequently, Nevada halted further reviews of DOE's permit applications, saying such reviews are "moot" and "unnecessary." Nevada's refusal to act on DOE's permit applications prevents DOE from conducting any site characterization activities at the site. The federal government filed suit on January 25, 1990, seeking, among other things, an order requiring the state to act on the permit applications within 30 days.

Impact of Recent Changes to Site Characterization Program

On November 29, 1989, DOE announced a new action plan for restructuring the nuclear waste program. Specifically, the Secretary of Energy's comprehensive review of the program resulted in what the Secretary called a "realistic" repository schedule, which extends the date for completing site characterization and submitting a repository license application to NRC until October 2001—a delay of almost 7 years. In the short term, DOE delayed by 3 years beginning (1) construction of the exploratory shaft facility until November 1992 and (2) underground tests in the facility until September 1995. DOE said it would use the extended schedule to overcome existing program obstacles.

In addition, DOE also shifted the initial focus of the site characterization program from underground testing to surface-based testing. According to DOE, beginning in January 1991, the surface-based program will be used to make a preliminary determination of the site's suitability for repository development. This approach appears to address issues raised by Nevada, NRC, and a utility group.

The revised schedule and approach, according to DOE, reflect its commitment to a technically sound and cost-effective site characterization program that is not linked to an unrealistic schedule. It may take several years to determine if DOE is meeting this commitment. One early indication of DOE's performance, however, will be its effectiveness in addressing and resolving the issues raised by NRC, Nevada, and others on its site characterization plan before conducting related characterization activities.

DOE Intends to Use Schedule Delay to Address Existing Program Obstacles

In the November 1989 action plan, DOE said it will use the extended schedule to, among other things, surmount current program obstacles that so far have prevented it from beginning characterization work at the site. First, DOE said that it had underestimated the effects of regulatory requirements for quality assurance and that it now expects to have the necessary programs in place and approved by NRC by August 1990, or 5 months before DOE plans to begin tests from Yucca Mountain's surface. Second, DOE stated that it will use the extended schedule to carefully reevaluate its plans for the exploratory shaft facility, as recommended by the Board and NRC. Finally, DOE intends to pursue all available options, including the litigation previously discussed, to resolve—by January 1991—the current impasse with Nevada about permits.

Surface-Based Testing Approach Appears to Address Issues Raised by Others

DOE had intended to conduct underground tests in the exploratory shaft facility concurrent with investigations conducted at or near the surface of the site. According to the November 1989 action plan, however, DOE now intends to begin surface investigations in January 1991, before beginning underground tests. The surface investigations will be used in making a preliminary determination of the site's suitability. The revised approach appears to address issues raised by Nevada, NRC, and a utility group.

In commenting on DOE's December 1988 plan, for example, the state of Nevada had maintained that DOE's approach to site characterization was fundamentally flawed because it did not provide for early investigations of potentially disqualifying conditions. The state recommended that before constructing the exploratory shaft facility, DOE should conduct tests from the site's surface to determine if disqualifying conditions are present. Further, although NRC and the utility group did not advocate a surface-based approach, both said that DOE should investigate possible disqualifying conditions early in site characterization. For example, the

utility group said DOE needs to address as early as possible the possibility that the site may be found unsuitable in order to avoid years of costly site characterization work. The group said this approach is central to the effective management of the repository program.

DOE's schedule assumes that it will receive the necessary permits in time to begin surface investigations in January 1991. However, in the November 1989 action plan, DOE said this assumption is optimistic.

New Emphasis on Excellence Over Schedule Provides DOE Opportunity to Address Issues Raised by Others

According to DOE's November 1989 action plan, the Secretary is committed to making scientific investigations—not the program schedule—the focal point of site characterization to ensure that the program and supporting activities will be scientifically based and technically sound. DOE said the prior schedule did not provide sufficient time to pursue an orderly program of site investigations needed to gather sufficient site characterization information. NRC and Nevada had previously criticized DOE for not allowing sufficient time to investigate the Yucca Mountain site. As recently as July 1989, for example, NRC said DOE's emphasis on meeting program milestones could preclude DOE from developing a complete, high-quality license application.

In addition to delaying site characterization, DOE deferred major design activities because of the redirection in its approach to investigating Yucca Mountain and the extension of its schedule. DOE said this delay will allow it to conserve resources and concentrate on scientific investigations of the site. DOE's extended schedule—in particular the time prior to beginning surface-based tests in January 1991—and its intention to concentrate on scientific investigations should also permit it to address and resolve the technical issues that NRC and others have raised on its plan for site characterization before it proceeds with characterization work.

Among those raising issues about DOE's December 1988 site characterization plan, NRC, for example, identified 133 serious concerns that, in its view, required DOE's early attention to avoid future licensing problems. One concern involved problems with DOE's coordination of planned characterization activities. It appeared to NRC that DOE had intended to drill boreholes and dig trenches either before or without conducting other activities that could provide information on the best locations for these boreholes and trenches. Also, it was not clear, NRC said, that DOE had planned to use data obtained from holes drilled for one investigation as possible input for other investigations, or that it had minimized the

number of holes (to minimize the potential damage to the site) by selecting borehole locations usable for diverse investigations. In commenting on DOE's site characterization plan, both Nevada and the utility group also raised concerns that, they said, required DOE's timely attention. (App. II discusses in greater detail the impact of recent changes in DOE's schedule and approach for developing a repository.)

Methodology

To assess DOE's readiness to begin site characterization and the impact of recent changes in DOE's schedule and approach for developing a repository, we obtained and reviewed (1) comments and concerns submitted by NRC, the state of Nevada, and a utility group representing the nuclear industry on DOE's December 1988 site characterization plan; (2) correspondence between DOE and the Nuclear Waste Technical Review Board; (3) information pertaining to Nevada's assertion that it has disapproved the selection of Yucca Mountain as a repository site; (4) DOE's November 29, 1989, action plan for restructuring the repository program; and (5) other related documents.

We discussed the facts presented here with cognizant officials of DOE, NRC, the state of Nevada, the Nuclear Waste Technical Review Board, and a group representing the nuclear industry, and we incorporated their comments where appropriate. As requested, however, we did not obtain official comments on the report. DOE officials were critical that we had not independently evaluated the external comments on its site characterization plan and DOE's recent progress in addressing them. Such an evaluation was beyond the scope of our review. In contrast to DOE's view, however, each of the other parties said we had adequately described their current views about existing program problems. Our work was performed between September 1989 and December 1989.

We are sending copies of this report to the Chairmen of the Senate Committee on Governmental Affairs, the House Committee on Government Operations, and the House Committee on Energy and Commerce; the

Secretary of Energy; the Chairman, Nuclear Regulatory Commission; and other interested parties. If you have any questions, please contact me at (202) 275-1441.

Major contributors to this report are listed in appendix III.



Victor S. Rezendes
Director, Energy Issues

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Abbreviations

DOE	Department of Energy
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act

Three Obstacles Prevented DOE From Beginning Site Characterization at Yucca Mountain

The Department of Energy (DOE) had planned to begin in November 1989 site characterization (investigation) activities at Yucca Mountain, Nevada, including construction of an exploratory shaft facility for underground tests and experiments. By that time, however, DOE was not ready to construct the facility or to begin other site characterization activities, because it had not

- demonstrated that its quality assurance programs for site characterization meet NRC's requirements,
- resolved concerns about the design of the exploratory shaft facility and the proposed method for constructing it, and
- obtained environmental permits from the state of Nevada that are necessary for facility construction and other site characterization activities.

Background

The Nuclear Waste Policy Act of 1982 (NWPA) established a federal program and policy for disposal of high-level radioactive waste (nuclear waste) in one or more geologic repositories. Subsequently, on December 22, 1987, the President signed into law the Nuclear Waste Policy Amendments Act of 1987.¹ The amendments made substantial changes to NWPA and to the manner in which DOE conducts its nuclear waste disposal program. Most important to the topic at hand, the amendments directed DOE to characterize only Yucca Mountain, Nevada, as a possible repository site and to terminate all activities (except reclamation) at two other sites. If and when, on the basis of DOE's investigation, Yucca Mountain is selected as a repository site, the agency would apply to the Nuclear Regulatory Commission (NRC) for authorization to construct a repository there. The latter agency would then have 3 years to review and hold a public hearing on the application and decide whether to authorize repository construction.²

NWPA, as amended, requires DOE to obtain comments from NRC and the state of Nevada on a plan for characterizing the site before it sinks exploratory shafts for underground testing. DOE is also required to make the plan available to the public and to conduct public hearings on the plan. The site characterization plan describes, among other things, DOE's

¹The 1987 amendments are contained within Title V of the Budget Reconciliation Act for Fiscal Year 1988 (P.L. 100-203).

²NWPA, as amended, permits NRC to extend, for good cause, the time for deciding on the construction authorization by up to 12 months.

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(1) approach to gathering information necessary to determine the suitability of the Yucca Mountain site for a repository and (2) preliminary designs for the repository and the exploratory shaft facility.

On December 28, 1988, DOE issued its plan for characterizing the Yucca Mountain site. According to DOE, the plan had been substantially revised as a result of comments received on an earlier draft. Subsequently, NRC, the state of Nevada, and others commented on the final plan, and DOE held public hearings on it.

When DOE had planned to begin the site characterization program in November 1989, the first major step would have been the construction of an exploratory shaft facility for underground tests and experiments. As designed, the facility would have consisted of a primary exploratory shaft; a second shaft for ventilation, handling of materials, and emergency exit; underground testing areas in tunnels and rooms; and surface facilities. As discussed in appendix II, in November 1989 DOE announced it will delay construction until November 1992.

DOE Had Not Demonstrated the Adequacy of Its Quality Assurance Programs

One obstacle that prevented DOE from beginning site characterization in November 1989 was the inadequacy of its quality assurance programs for conducting site work. NRC's repository licensing regulations require DOE and its contractors to implement quality assurance programs for site characterization work, because DOE may use this work to demonstrate, in a future licensing proceeding, that the repository can be operated safely and that it can isolate waste for the required period of time. If DOE cannot document adequately that site characterization work has been conducted in conformance with NRC's quality assurance standards, it will have trouble licensing the facility. Because of the importance of quality assurance to the success of the repository program, DOE agreed, in 1985, that its quality assurance program for key site characterization activities should be in place before beginning the work. Further, DOE said it would request NRC to audit the program to demonstrate compliance with the requirements before it begins site characterization.

NRC's quality assurance regulations require DOE and its contractors to, among other things, (1) inspect and audit activities that affect quality, (2) establish controls over testing programs and equipment, (3) establish and maintain quality assurance records, and (4) correct identified problems. In its July 31, 1989, comments on DOE's final site characterization plan, NRC acknowledged that DOE and its contractors were developing and beginning to implement their quality assurance programs. NRC said,

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however, that none of the programs yet met its requirements. Because of the importance of this concern, NRC objected to DOE's proceeding with site characterization until DOE demonstrates to NRC that its programs are adequate for beginning site work.³

NRC's objection to DOE's final plan reflects a continuing concern about the condition of DOE's quality assurance programs and the pace at which DOE is implementing them.⁴ In July 1988 the agencies agreed that after DOE submits and NRC reviews a total of nine DOE and DOE-contractor quality assurance plans, and after NRC is satisfied that DOE and its contractors are implementing the plans successfully, NRC will "accept" each quality assurance program, that is, consider each as adequate for beginning site characterization.⁵ In July 1988 DOE anticipated that NRC would be able to accept the nine programs by May 1989. However, in January, July, and November 1989, DOE delayed its scheduled date for obtaining NRC's acceptance of the programs. All quality assurance programs needed for DOE's short-term work are currently scheduled to receive NRC's acceptance by August 1990.

According to NRC, the objection will remain in effect until (1) NRC is satisfied that each program participant has an adequate quality assurance program in place for early site characterization work and (2) DOE has resolved NRC's concerns about the quality of DOE's design for the exploratory shaft facility (discussed below). In the interim, however, NRC said DOE could begin early site characterization work in individual program areas after DOE demonstrates, and NRC agrees, that the applicable quality assurance program is acceptable. NRC added, however, that establishing adequate quality assurance programs on DOE's schedule may be difficult because DOE has not filled field and headquarters management positions in the quality assurance area. NRC recommended that these positions be filled with appropriately knowledgeable and experienced individuals as soon as possible.⁶

³NRC's licensing regulations require NRC to identify in its analysis of the plan any specific objections to DOE's site characterization program that it may have. According to NRC, an objection is a matter of such immediate importance to a particular portion of the site characterization program that DOE should not start work in that area until the issue is resolved satisfactorily.

⁴NRC had previously raised an objection in this area in its comments on DOE's draft site characterization plan.

⁵DOE will still need to develop, implement, and receive NRC's approval of quality assurance programs needed for later program activities.

⁶DOE filled the field quality assurance manager position in October 1989.

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NRC's Advisory Committee on Nuclear Waste—a committee of experts appointed by the NRC commissioners to advise them on nuclear waste matters—also expressed concern about DOE's delay in implementing adequate quality assurance programs. In a July 3, 1989, letter to the Chairman of NRC, for example, the Advisory Committee said that the NRC staff had been "extremely tolerant" of DOE's delays in implementing the programs. In the Advisory Committee's view, adequate quality assurance systems need to be in place promptly because the continued absence of them will increase DOE's burden of demonstrating, in a future licensing proceeding, that data collected during site characterization are accurate.

The Edison Electric Institute and the Utility Nuclear Waste and Transportation Program, which together represent the majority of utilities operating nuclear power plants, also criticized DOE's efforts to develop adequate quality assurance programs. In its June 1, 1989, comments on DOE's plan, the group supported a sound, rigorous, and NRC-approved quality assurance program; however, it said DOE's progress toward this goal has been "slow and unsteady." It added that because DOE's quality assurance program would not be ready for DOE to begin constructing the exploratory shaft facility in November 1989, the entire repository program would be delayed. Furthermore, the group said it was particularly concerned about DOE's failure to maintain qualified management leadership in the quality assurance area. It stated that filling the vacant director's position in the headquarters' quality assurance office with a highly skilled and experienced person is vital to the overall high-level waste program. Consequently, the utility group concluded that DOE should act quickly to fill the vacancy.

Finally, in December 1989 the utility group provided NRC with its comments on NRC's analysis of DOE's site characterization plan. The utility group stated that it basically agrees with NRC's objection in the quality assurance area. Further, the group said NRC's approach to resolving the objection is both technically sound and procedurally efficient.

DOE Had Not Resolved Concerns About the Design and Construction of the Exploratory Shaft Facility

The exploratory shaft facility is an important part of DOE's site characterization plans; if DOE eventually constructs a repository at the Yucca Mountain site, the facility will become a part of the repository and, therefore, will be subject to all regulatory requirements for repositories. Thus, that the facility be free from design and construction errors is important. DOE's final site characterization plan, however, did not resolve satisfactorily the following key concerns about the design and the proposed method for constructing the exploratory shaft facility:

- NRC concluded that the plan and related documents did not demonstrate that the design of the exploratory shaft facility meets regulatory requirements for repositories.
- The state of Nevada questioned DOE's previous intention to proceed with the design and construction of the facility before completing studies of technical issues that may affect the final design of the facility, issues such as seismic design requirements.
- The Nuclear Waste Technical Review Board recommended that DOE change the method by which it had planned to construct the facility to, among other things, ensure that construction techniques would not adversely affect the site or the interpretation of test results.

DOE Had Not Demonstrated That Facility Design Meets NRC Requirements

In mid-1988 NRC told DOE that the latter agency had not established effective controls to ensure that the design of the exploratory shaft facility meets all applicable NRC regulatory requirements for repositories. DOE agreed to correct this problem in future design work on the facility and to analyze the acceptability of its completed design work. In commenting on DOE's final site characterization plan and the supplemental design acceptability analysis, however, NRC concluded that DOE still had not demonstrated the technical adequacy of the design of the facility and of the process followed in performing facility-design work. Therefore, NRC objected to DOE's proceeding with construction of the facility before demonstrating that both the facility design and the process used to design the facility comply with NRC's regulatory requirements.

According to NRC, the exploratory shaft facility is crucial to waste isolation because it would be the interface in any future repository and would become part of the repository itself if the site is found suitable and developed by DOE. Also, how the facility is sited, designed, and constructed could affect (1) the validity of data derived from site characterization tests and (2) long-term waste isolation and repository performance. Consequently, the exploratory shaft facility must be

designed under the same quality assurance requirements applicable to a repository. One requirement is to establish a process for controlling repository design work to, among other things, ensure that regulatory requirements—such as requirements for ensuring waste isolation—are correctly translated into specifications, drawings, and instructions for constructing a repository.

In a July 1988 meeting, NRC told DOE that the latter's design work for the exploratory shaft facility was not being conducted under adequate quality controls. For example, though NRC requires that site characterization work be conducted in a manner limiting, to the extent practical, adverse effects on long-term repository performance, it found in reviewing DOE's January 1988 draft site characterization plan that DOE did not consider adequately the potential adverse effects of locating the two shafts in areas possibly subject to flooding and erosion. According to NRC, if DOE's design control process had been adequate, DOE would have found that the preliminary design contained in the draft plan did not consider adequately this and other applicable regulatory requirements.

At the July 1988 meeting, DOE said that it had intended to apply the required quality assurance measures to the facility's design after beginning construction of the facility. NRC advised DOE that this approach would not, in some cases, identify design problems early enough to correct them; for example, if DOE would disturb the site by sinking the two exploratory shafts and later find out that the locations were incorrect, it could not correct the error.

In October 1988 DOE decided to delay beginning the construction of the exploratory shaft facility 5 months—from June 1989 to November 1989—so it could improve its design control process before beginning the facility's detailed construction design. DOE said it would ensure that future facility-design activities meet NRC's quality assurance standards. It also agreed to analyze in a report supplementing the site characterization plan the acceptability of its earlier facility-design work. This report—the design acceptability analysis—was intended to validate the facility-design work that DOE planned to include in the final site characterization plan. The analysis identified regulatory requirements that DOE believes are applicable to design work and included DOE's assessment of whether the design—including, for instance, DOE's choices of the exploratory shaft locations—meets these requirements.

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According to NRC, the final site characterization plan and accompanying references, such as the design acceptability analysis, did not demonstrate that the design of the exploratory shaft facility contained in the final plan was adequate.⁷ Further, it said, resolving facility design problems could require considerable modifications to the site characterization plan. Consequently, NRC objected to DOE's starting construction on the facility before DOE demonstrates that both the design of the facility and the process used to develop the design are adequate.

NRC based its objection on two fundamental concerns. First, NRC said DOE did not consider 11 applicable regulatory requirements and did not consider adequately at least 30 of 52 other requirements. Also, DOE did not check thoroughly the adequacy of design data, for instance, by reviewing several key documents used in developing the design. In addition, NRC questioned the independence of some reviewers involved in the analysis because they either authored, reviewed, and/or contributed to specific documents used as input to the facility's design. These shortcomings, NRC said, raised questions about the completeness and rigor of DOE's analysis. Second, NRC said DOE's design acceptability analysis did not demonstrate that DOE had considered available information on the potential presence of a fault near the proposed exploratory shaft locations. That DOE apparently overlooked such key information heightened NRC's concern about the adequacy of DOE's process for controlling design work.

In addition, NRC said DOE's design analysis did not demonstrate that the underground test area in the exploratory shaft facility can accommodate planned tests and preclude interference between tests and construction operations.

To address these concerns, NRC recommended that DOE

- design the facility to minimize uncertainty about waste isolation in the final repository;
- evaluate existing technical data regarding the location of the facility and, if necessary, consider additional surface-based testing near shaft locations to investigate potentially adverse features and conditions;

⁷The design in the final site characterization plan was more advanced than the one presented in DOE's draft plan. However, DOE must still develop its detailed design for constructing the exploratory shaft facility.

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- present the rationale for selected test durations, address the suitability of established test durations, and assess associated impacts on the testing program in its construction design;
- provide a complete conceptual design of the main test area and related test schedule in the facility's construction design to account for contingencies such as the need for running tests longer than planned and the possibility of encountering areas unsuitable for testing; and
- implement an acceptable quality assurance program, including an adequate process for controlling design work, before beginning the detailed construction design of the exploratory shaft facility.

After reviewing NRC's proposed comments on DOE's final site characterization plan, NRC's Advisory Committee recommended that DOE address the errors and deficiencies in the preliminary design before proceeding with the advanced construction design of the facility. Although NRC did not specifically recommend this course in commenting on the final plan, it criticized DOE's decision to proceed with the advanced design before demonstrating that its quality assurance programs are adequate to perform the work.

In its December 1989 comments on NRC's analysis of the site characterization plan, the utility group said it basically agrees with NRC about the need for DOE to demonstrate the adequacy of both the exploratory shaft facility design and the process used to develop the design before DOE proceeds with the facility's construction.

Nevada Recommended That Technical Issues Possibly Affecting the Facility's Design Should Be Studied Prior to Construction

In its September 1, 1989, comments on the plan, the state of Nevada also expressed concerns about DOE's design for the exploratory shaft facility. One of the state's major concerns was about the seismic design criteria DOE planned to use in constructing the facility. According to the state, DOE intended to design the facility to withstand an earthquake that is less severe than the plan implied could occur near the site. Given that the exploratory shaft facility would be integrated into a future repository, the state said a more conservative design is more scientifically acceptable. Further, the state criticized DOE's plan to begin designing and constructing the facility before the results of studies intended as input for the facility's design are available. Consequently, the state said it is inappropriate for DOE to proceed with the facility's construction until design issues are resolved and enough surface-based testing results become available to provide reasonable assurance that the integrity of the repository will not be compromised by an inadequate seismic design.

Board Recommended That DOE Consider Changing the Method for Constructing the Facility

The December 1987 amendments to NWPA established the Nuclear Waste Technical Review Board to, among other things, evaluate the technical and scientific validity of DOE's site characterization activities. Because of delays in appointing members, however, the Board did not become operational until early 1989. As a result of its early work, the Board identified numerous concerns about the exploratory shaft facility and recommended changes to DOE's proposed method for constructing the facility.

DOE had intended to use conventional drill and blast construction techniques to excavate the exploratory shaft facility. According to the Board, however, using explosives to construct the facility would (1) disturb the rock walls in the shafts and tunnels, (2) introduce water into rock fractures during the drilling of blast holes, and (3) complicate the interpretation of test results.

The Board was also concerned that DOE's plan for excavating the facility would not yield sufficient early site characterization data. For example, it said DOE's plan did not provide for (1) sufficient observation, measurement, and sampling of the Ghost Dance fault, which is known to run through the repository block, or (2) the early detection of other fault zones that could exist at the site. The Board said DOE needs to excavate more of the repository area, as early as possible, to assess whether potentially disqualifying geologic features exist at the site.

These views are similar to comments raised by NRC in its comments on the plan. For example, NRC said DOE's excavation program probably would not provide sufficient information to (1) investigate adequately potentially adverse conditions at the site or (2) ensure that observations made and data collected will be representative of the entire repository area. NRC said DOE's program appeared to be biased heavily toward investigating the northern repository area although other areas may have different geologic features, for instance, greater fault displacement.

The Board believes that many of its concerns can be reduced or eliminated if DOE uses what the Board termed "state-of-the-art" mechanical excavation techniques, which would be quicker and less costly than conventional explosive techniques. According to the Board, these methods would also facilitate DOE's search for and inspection and investigation of faulting at the site.

DOE assessed the Board's recommendations in three separate reports. The reports

- evaluated other construction methods as a means to minimize geologic disturbance and the introduction of water in the area surrounding the exploratory shafts,
- examined whether it would have been feasible and advantageous to defer or relocate tests DOE had planned to conduct during construction of the first shaft,
- analyzed whether DOE's excavation program would have allowed it to characterize adequately Ghost Dance fault and identify conditions that might exist in the other areas of the repository,
- evaluated the potential advantages of additional exploratory excavations designed specifically to investigate geologic features, and
- evaluated the effects of the Board's suggestions about shaft construction and exploratory drifting (tunnelling) on DOE's site characterization program.

According to a September 11, 1989, DOE letter to the Board, the evaluations acknowledge the merits of the Board's recommendations. Consequently, DOE said it will develop a plan to address them. As part of this effort, DOE said it will also evaluate additional recommendations made by the Board in August 1989. At that time, the Board recommended that DOE review the construction and configuration of the proposed exploratory shaft facility, considering the use of modern techniques to construct the first shaft and the Board's recommendation to increase the proposed diameter of this shaft from 12 feet to between 18 and 20 feet because, in its view, the larger shaft may be less costly, safer to construct, and more useful. The Board also recommended that DOE consider constructing an inclined tunnel, or ramp, in lieu of the second shaft. The tunnel would be advantageous, the Board said, because it could be constructed rapidly and could provide access for experimental alcoves at any areas of interest.

DOE Had Not Obtained Permits Needed for Site Characterization

Another reason DOE was not ready to begin construction of the exploratory shaft facility in November 1989 was the state of Nevada's refusal to issue certain environmental permits that are needed to begin construction of the exploratory shaft facility or other site characterization activities. Nevada believes that it has successfully disapproved Yucca Mountain as a repository site because the Congress did not respond to two joint resolutions of the Nevada legislature that, in the state's view, constitute its formal notice of disapproval under NWPA, as amended.

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Consequently, the state has halted further review of DOE's permit applications because it considers such action "moot" and "unnecessary."

After site characterization and upon submission by the President to the Congress of a site recommendation for a repository, Section 116(b) of NWPA, as amended, allows the governor or the legislature of the state in which the site is located to submit a notice of disapproval. The notice must be accompanied by a statement explaining why the governor or state legislature has disapproved the repository site. In the event that a notice of disapproval is submitted, the Congress can override the disapproval by passing a joint resolution of repository siting approval within 90 days. Otherwise, the state's notice of disapproval constitutes disapproval of the site.

Nevada believes that its April 19, 1989, transmittal of two legislative resolutions to the Congress constitutes its formal notice of disapproval. According to Nevada, the resolutions express the state legislature's will regarding both the constitutional and statutory bases for rejecting a repository in Nevada. Moreover, on July 6, 1989, the Governor of Nevada signed a law that makes it unlawful for any person or government entity to store high-level radioactive waste in Nevada. According to the state's attorney general, enactment of this law removed any conceivable doubt about the state's intent and policy regarding the repository.

Finally, the state argues that its notice of disapproval at this time, rather than after a presidential recommendation of the site, is appropriate and consistent with NWPA, as amended. As previously discussed, NWPA allows the state to issue a notice of disapproval if the President recommends to the Congress that Yucca Mountain be developed as a repository. Under NWPA as originally enacted, the recommendation would be made after DOE has (1) completed site characterization at three sites and (2) selected a single site for repository development based on a comparative evaluation of the sites. In the attorney general's opinion, however, the amendments to NWPA that eliminated sites in Washington and Texas from consideration as possible repository sites also eliminated the need for the state to await a presidential recommendation that Yucca Mountain be selected for repository development. Now, the state maintains, if Yucca Mountain is found suitable for a repository, the site will be recommended "pro forma" to the President by the Secretary of Energy and, in turn, by the President to the Congress. Further, according to the state, both of these recommendations may be anticipated by

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the Secretary's preliminary determination in May 1986 stating Yucca Mountain's suitability for repository development.

Because the Congress did not act on the legislative resolutions, the state believes that the Congress has sustained the state's notice of disapproval. In October 1989, the Governor of Nevada asked the state's attorney general for an opinion on whether the state should consider DOE's permit applications in view of the Congress' "failure to act" on the state's notice of disapproval.

On November 1, 1989, the Nevada attorney general issued an opinion in this matter. The attorney general concluded, among other things, that Nevada is legally justified in rejecting a high-level nuclear waste repository at Yucca Mountain on the grounds of economic and environmental endangerment, and that the state legislature had rejected it in the two joint resolutions it transmitted to the Congress. Because the Congress did not respond to the state's notice of disapproval within the 90-day limit, the attorney general said, the state can presume that (1) the Yucca Mountain site is disapproved by the Congress and (2) the site shall not be considered for development as a repository. Therefore, the attorney general advised that further action on DOE's pending applications for permits is unnecessary. Following receipt of the opinion, the Governor of Nevada directed state agencies to halt their reviews of DOE's permit applications.

On January 25, 1990, at the request of DOE, the Department of Justice filed a complaint in the U.S. District Court for the District of Nevada. The complaint seeks, among other things, (1) a declaratory judgment that the state's refusal to act on the permit applications violates NWPA and the U.S. Constitution and (2) an order requiring the state to act on the applications within 30 days.

Based on assertions in the complaint, the federal government's position is that Nevada's "purported submission" to the Congress of the state's joint resolutions before the President had made any recommendation to the Congress concerning the site was premature and is "not a valid and effective notice of disapproval" under NWPA. Therefore, according to the complaint, the Congress was not required to act on the notice within the time periods specified in the act and has not vetoed Yucca Mountain as a potential site for a high-level nuclear waste repository. Accordingly, the complaint further asserts, DOE's permit applications are not moot and the state's refusal to act on them is contrary to law. Finally, according to the complaint, the actions of the state in enacting legislation that has the

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effect of prohibiting storage of high-level nuclear waste in Nevada are preempted by NWPA, to the extent that they directly conflict with the act and interfere with the accomplishment of its purposes and objectives.

Impact of Recent Changes in DOE's Site Characterization Program

On November 29, 1989, DOE announced a new action plan for restructuring the nuclear waste program. Specifically, the Secretary of Energy's comprehensive review of the program resulted in what the Secretary called a "realistic" repository schedule, which extends the date for completing site characterization and submitting a repository license application to NRC until October 2001—a delay of almost 7 years. In the short term, DOE delayed beginning (1) construction of the exploratory shaft facility until November 1992 and (2) underground tests in the facility until September 1995. DOE plans to use the extended schedule to overcome the three program obstacles—delays in implementing adequate quality assurance programs, deficiencies related to the design and construction of the exploratory shaft facility, and lack of access to the site—that so far have prevented it from beginning characterization work at the site.

In addition, beginning in January 1991, DOE intends to perform surface-based testing before constructing the exploratory shaft facility for underground tests. According to DOE, the surface-based program will be used to make a preliminary determination of the site's suitability for repository development. This approach appears to address issues raised by Nevada, NRC, and the utility group.

The revised schedule and approach, according to DOE, reflect its commitment to a technically sound and cost-effective site characterization program that is not linked to an unrealistic schedule. It may take several years to determine if DOE is meeting this commitment. One early indication of DOE's performance, however, will be its effectiveness in addressing and resolving the issues raised by NRC, Nevada, and others on its site characterization plan before conducting related characterization activities.

DOE Intends to Overcome Existing Program Obstacles

The House Committee on Appropriations directed DOE to submit within 60 days of the enactment of the Energy and Water Development Act, 1990, (P.L. 101-101) a report describing how DOE plans to respond to the Committee's concerns about the agency's management of the civilian high-level waste disposal program, including its concerns about "endemic" schedule slippages. Responding to this directive, on November 29, 1989, DOE announced a new strategy based on the Secretary of

Energy's comprehensive review of the program.¹ DOE stated that under the new schedule it plans to

- obtain access to the site and begin an approximately 11-year surface-based testing program in January 1991,
- construct the exploratory shaft facility between November 1992 and September 1995,
- conduct underground tests between September 1995 and October 2001,
- submit a repository construction application to NRC in October 2001, and
- begin repository operations by 2010.

DOE cautioned that the later dates in the new schedule are only reasonable targets. However, DOE pledged its best efforts to meet the revised estimates and to improve this schedule consistent with its goals of safety and scientific excellence.

DOE said it will use the additional time to, among other things, surmount current program obstacles. For example, DOE acknowledged that it had underestimated the impact of regulatory requirements for quality assurance and design control on the repository's schedule. Thus, DOE said that under the extended schedule, it will effect needed improvements in these areas. DOE estimated that its quality assurance program will be fully qualified and approved by NRC for short-term work in August 1990, or 5 months before DOE plans to begin the surface-based testing program at the Yucca Mountain site.

In addition, DOE said it will carefully reevaluate its plans for the exploratory shaft facility, as recommended by NRC and the Nuclear Waste Technical Review Board. As previously discussed, NRC had recommended that DOE reevaluate the design of the facility, including shaft locations, and the design control process before proceeding to construct the facility. Also, the Board had recommended that DOE change its proposed method for constructing the facility and consider a horizontal ramp rather than a vertical shaft in place of one of the two proposed facility shafts.

Finally, DOE said that it will pursue all available options to resolve the impasse with the state of Nevada about the environmental permits necessary for site characterization to begin. DOE recognized that cooperation

¹ Report to Congress on Reassessment of the Civilian Radioactive Waste Management Program (DOE/RW-0247, Nov. 29, 1989).

and direct negotiations with the state are the best means to pursue scientific investigations at the site. But because DOE believes that beginning these investigations is critical to reestablishing confidence in the repository project, DOE initiated litigation against Nevada on January 25, 1990, to require the state to act on the permit applications, as discussed in appendix I. Although DOE's revised schedule assumes that it will receive the permits in sufficient time to begin surface-based site investigations in January 1991, this assumption is optimistic, according to the November 1989 action plan.

Surface-Based Testing Approach Appears to Address Issues Raised by Others

DOE had planned to conduct surface-based investigations—such as those in boreholes and trenches—concurrent with construction of and tests in the exploratory shaft facility. According to DOE's November report, however, beginning site characterization with a surface-based testing program is necessary to ensure that the characterization program will be scientifically based, technically sound, and cost-effective. According to DOE, it will use the surface-based testing program to make a preliminary determination about the site's suitability for repository development. In addition, the new approach will allow DOE to begin characterization work while it responds to concerns raised about the exploratory shaft facility. The revised approach is, according to DOE, very responsive to concerns raised by Nevada, NRC, and the utility group.

In commenting on DOE's site characterization plan, for example, Nevada had recommended that DOE structure the site characterization program around surface-based testing to determine, as early as possible, whether disqualifying conditions exist before constructing the exploratory shaft facility. In the state's view, this approach should be a fundamental part of "any objective, well conceived, and well managed site characterization program." The state said DOE's original characterization approach was fundamentally flawed because it did not include early investigation of conditions known to exist at the site that could disqualify the site from further consideration. For instance, Nevada said DOE had not planned to conduct early, concentrated data collection to (1) increase understanding about the effects of faulting and volcanic activity on the site's waste isolation capability and (2) assess the presence of natural resources at the site as well as the likelihood of future human intrusion that could compromise waste isolation. Further, the state said DOE had not established decision points for making an early assessment of suitability before it would have committed substantial resources to the site. Instead, the state said, DOE apparently would not have evaluated site

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characterization findings until the conclusion of the characterization program.

In addition, although NRC and the utility group did not advocate a surface-based approach, both said that DOE should investigate key suitability issues early in site characterization. In its comments on DOE's site characterization plan, for example, NRC said DOE had not given sufficient priority, early in site characterization, to issues that most significantly affect a determination about Yucca Mountain's suitability for a repository. One example of this deficiency was DOE's planned investigations of tectonic phenomena.² According to NRC, it appeared that DOE had not given sufficient priority to its tectonic investigations, nor ordered them appropriately, even though they are critical in identifying potentially disqualifying site conditions. NRC urged DOE to give early attention to investigations that can determine if the probability of disruption at the site by volcanic activity, faulting, and seismicity is unacceptably high.

Finally, the utility group had criticized DOE's final site characterization plan because it would not have led to an early evaluation of the site's suitability. According to the group, there is no current basis for concluding that the site is unsuitable; however, it is not inconceivable that DOE eventually might identify disqualifying conditions. Therefore, the group said, DOE should address this possibility as early as possible instead of after years of costly site characterization work. The group said that it would continue to emphasize this approach, which it feels is important to the effective management of the program.

DOE's decision to perform surface-based tests to evaluate the site's suitability before it commits resources to the construction of the exploratory shaft facility appears to address earlier criticisms by Nevada, NRC, and the utility group. However, the responsiveness of DOE's program to these concerns cannot be determined until the details of DOE's program, expected in late 1990, are available.

²Tectonic investigations involve studies of the earth's crust and the forces that produce changes in it, including faulting and volcanic and seismic activity.

New Emphasis on Excellence Over Schedules Provides DOE Opportunity to Address Issues Raised by Others

An underlying premise DOE used in developing its new program schedule is that the program and supporting activities must be scientifically based and technically sound. Therefore, the Secretary said he is committed to making scientific investigations—not the program schedule—the focal point of site characterization. According to DOE, the schedule created by NWPA was unrealistic, in part because it had been based on the mistaken view that the program is simply a construction project rather than a technically and institutionally unprecedented scientific investigation. As a result, the schedule did not allow DOE to conduct an orderly program of investigations needed to gather sufficient site characterization information. The revised schedule is, according to DOE, the first realistic assessment of the repository's schedule because it was rigorously developed based on past experience and the detailed information gathered for the site characterization plan. Preparing the plan, DOE said, has increased its understanding about the type and duration of activities that must be conducted during site characterization.

In addition to announcing the delay in site characterization, DOE announced that it would defer major design activities because of the redirection in its approach to investigating Yucca Mountain and the extension in the schedule. According to DOE, the design work will resume when more information on the suitability of the site is available. In the interim, DOE said the delay will allow it to conserve resources and concentrate on scientific investigations.

The restructuring of and delay in site characterization—together with DOE's stated commitment to technical excellence—can, if carried out, also allow DOE to resolve in a timely manner the issues raised by NRC, the utility group, and the state of Nevada about DOE's site characterization plan. For example, NRC's analysis of the plan identified 133 concerns that if left unresolved would adversely affect licensing. It also identified other serious concerns that, it said, should also receive DOE's early attention. One of NRC's concerns, which appears to have been resolved, is DOE's emphasis on program schedules over the technical quality of the characterization program. Two remaining concerns are about deficiencies in DOE's approach to modeling site characteristics³ and in DOE's coordination of site investigation activities. DOE's November 1989 action plan does not discuss how or when it intends to resolve issues raised about its site characterization plan.

³Models will be used to simulate and predict the long-term (10,000 or more years) geologic behavior at the site under different assumed conditions.

Criticism of DOE's Former Emphasis on Schedules Over Technical Excellence

NRC and Nevada previously had criticized DOE for not allowing sufficient time to investigate the Yucca Mountain site. For example, in commenting on DOE's June 1988 draft mission plan amendment, NRC said DOE's emphasis on meeting schedule milestones could preclude DOE from developing a complete and high-quality license application.

NRC reiterated this concern in its July 1989 comments on DOE's final site characterization plan. NRC also said DOE had not demonstrated that its schedule for conducting site characterization activities would be sufficient to gather the technical information necessary to understand the site and prepare a high-quality license application. At that time, NRC expressed particular concern about DOE's decision to proceed with the construction design for the exploratory shaft facility before meeting NRC's quality assurance requirements. In NRC's view, DOE's decision was made because of pressure to meet the schedule for constructing the exploratory shaft facility.

Nevada had also complained that DOE's site characterization schedule was far too short to assess adequately basic site characteristics and arrive at a determination of the site's suitability. Further, the state had criticized DOE's implicit assumption that Yucca Mountain is suitable for a repository. DOE's approach to characterizing the site, Nevada said, was contrary to NRC's licensing requirements because the approach did not provide a rigorous program incorporating the basic elements of a credible scientific investigation. According to the state, a credible approach would objectively evaluate alternative working hypotheses against a comprehensive data base in order to gain a supportable understanding of the site. In addition, such an approach would require DOE to rigorously test investigation results against established criteria to assess the site's suitability. Nevada said DOE's approach was, in contrast, designed to provide no more information than necessary for DOE to confirm its assumptions and, in conjunction, to assert that the site is suitable because information had not emerged that would obviously disqualify it.

In announcing the recent schedule extension, DOE acknowledged that the previous schedule had not allowed sufficient time to investigate adequately the site's suitability for development as a repository. Consistent with its new focus on the program's technical excellence, a schedule extension would be needed, DOE said, to ensure that scientific investigations are (1) scientifically based and technically sound and (2) separated from a scheduling process that constrains the time permitted for site investigations. The extension in DOE's schedule together with DOE's commitment to technical excellence appears to address earlier concerns.

about DOE's emphasis on program schedules over the technical adequacy of its characterization program.

**Criticism of DOE's
Consideration of
Alternative Site Models**

NRC and the utility group are concerned that DOE may not investigate a sufficient number of models for the Yucca Mountain site. NRC had been so concerned that, in commenting on the approach described in the draft site characterization plan, it objected to DOE's beginning site characterization before correcting deficiencies in its approach; after reviewing the final plan, NRC rescinded its objection. According to NRC, however, its remaining concerns in this area are serious and warrant DOE's early attention.

DOE's "failure to recognize the range of alternative conceptual models of the Yucca Mountain site that can be supported by the existing limited data base" was NRC's most fundamental technical objection to the draft site characterization plan. NRC considered the issue of such immediate importance that it objected to DOE's beginning site characterization until the issue was resolved satisfactorily. Although DOE had identified more than one model of the site in the draft plan, NRC commented that the site characterization program appeared primarily designed to collect information in support of DOE's preferred conceptual model. If this issue is not resolved satisfactorily before DOE begins site characterization, NRC had said, early work could physically compromise DOE's ability to conduct future investigations that may be found necessary for repository licensing purposes.

NRC raised similar concerns in its March 1985 and December 1986 comments on DOE's draft and final environmental assessments for the Yucca Mountain site. For example, in March 1985, NRC said that DOE had not recognized in the draft environmental assessment the full range of uncertainty about factors affecting the site's suitability. NRC said DOE's conclusions and findings, in some instances, (1) were not supported by existing data or (2) were based on data that were not conservative.

DOE's consideration of alternative conceptual models in the final plan was sufficiently improved for NRC to withdraw its previous objection in this area. On the basis of its review, NRC said the range of models considered in DOE's final plan appeared sufficient to ensure that DOE probably will not omit essential investigations. Nonetheless, NRC still has serious concerns in this area. At a July 1989 staff briefing of the NRC commissioners, for example, one commissioner remarked that the staff's decision to rescind this objection had been a "close call," which, in view of

the seriousness of NRC's remaining concerns in this area, should not be misconstrued by DOE. Because deficiencies in modeling could adversely affect licensing, NRC said DOE should treat the issue more effectively, early in site characterization.

The continued significance that NRC accords the alternative modeling issue is illustrated by its comment that DOE's tectonics investigations appear to be directed toward providing data to confirm DOE's preferred tectonic model, rather than toward eliciting the full range of models that existing data can support. For example, NRC said DOE's plan assumed that faulting will not be encountered in the proposed waste emplacement area inside Yucca Mountain even though available information implies that a fault zone may exist in this area. Also, NRC said many of DOE's characterization, design, and performance parameters (assumptions) were not sufficiently conservative and could lead to overoptimistic predictions about the effects of faulting on the repository's performance and to inadequate investigation of relevant geologic features.

The Advisory Committee on Nuclear Waste said, in a July 3, 1989, letter to the Chairman, NRC, that the models described in DOE's final plan were incomplete and not well coordinated. The Advisory Committee said DOE's plan for site characterization should collect data necessary to identify the correct model rather than data to confirm DOE's preferred model. Because modeling is essential for evaluating the performance of the proposed repository and for uncovering potentially disqualifying features at the site, the Committee said DOE must correct these modeling deficiencies.

According to the utility group, disputes about DOE's consideration of alternative site models may also arise during licensing if DOE cannot demonstrate that it has evaluated a representative range of possible site models. The group said licensing difficulties are likely because of DOE's heavy reliance on the judgments of experts to interpret site data and the likelihood that there will be disagreement on these interpretations. Every step beyond acquisition of data (from interpretation of data through defense of the final results in a licensing proceeding) will rely principally on expert judgment. Challenges of expert judgment can be formidable and difficult to resolve during licensing. Of particular concern is that interpretations will involve predictions about conditions for the next 10,000 or more years. Consequently, the group said one approach for dealing with disputes during licensing is for DOE to demonstrate that it has selected an adequately representative range of models.

DOE's November 1989 extension in the schedule gives DOE the opportunity to resolve this longstanding concern before it begins investigations at the site.

**Criticism of DOE's
Coordination of Site
Characterization Activities**

NRC said that DOE needs to coordinate more effectively its overall site characterization program. For example, NRC said even though tectonics investigations are needed as input for assessments of potentially adverse conditions, under the final site characterization plan, they may not have been carried out until the assessments had begun. Also, it appeared to NRC that DOE had planned to conduct intrusive activities, such as drilling and trenching, either before or without conducting nonintrusive activities that could provide information needed to select the best locations for proposed boreholes and trenches. Likewise, it was not clear, NRC said, that DOE had planned to use data obtained from holes drilled for one investigation as possible input for other investigations, or that it had minimized the number of holes (to minimize the potential damage to the site) by selecting borehole locations usable for diverse investigations.

In addition, NRC said that DOE's plan did not reflect an understanding about the need to systematically coordinate the models across the various technical disciplines. For example, although it is important to recognize that volcanic activity and faulting are often closely associated in arriving at an understanding of a geologic setting, NRC said, whether DOE will consider relevant tectonic processes in site characterization assessments related to volcanic activity was not clear.

Nevada also commented that DOE's site characterization plan did not coordinate adequately the planned study and data collection activities. According to the state, this weakness would preclude DOE from carrying out assessments of the repository's performance and evaluating alternative conceptual models. Also, the state said, this weakness has reinforced its earlier position that DOE's characterization approach was designed more to confirm its preconceived notion of a simplified site model than to identify, through site investigations, the conceptual model that can be supported by objective, comprehensive data collection and analysis.

DOE's schedule extension provides DOE with time to strengthen its coordination of related site characterization activities before beginning the investigations.

Major Contributors to This Report

Resources,
Community, and
Economic
Development Division,
Washington, D.C.

John W. Sprague, Associate Director
Dwayne E. Weigel, Assistant Director
Kathleen J. Turner, Evaluator-in-Charge
John H. Skeen, III, Writer-Editor

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